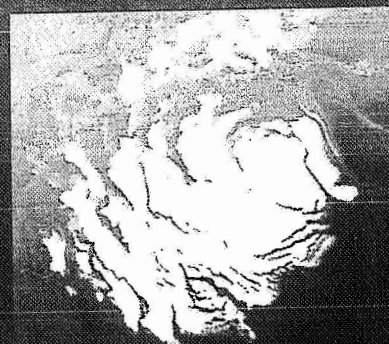
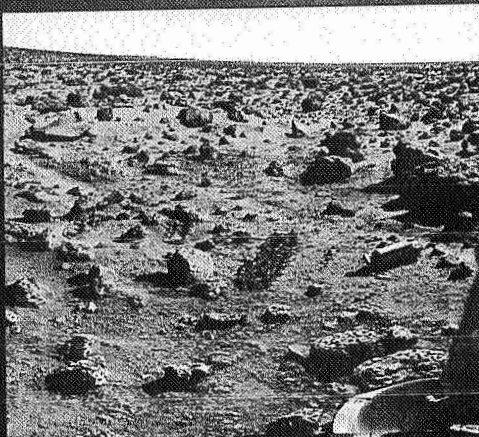
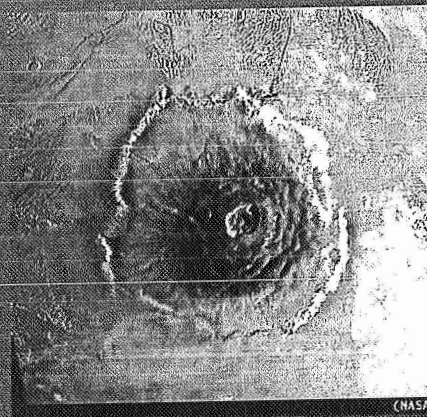
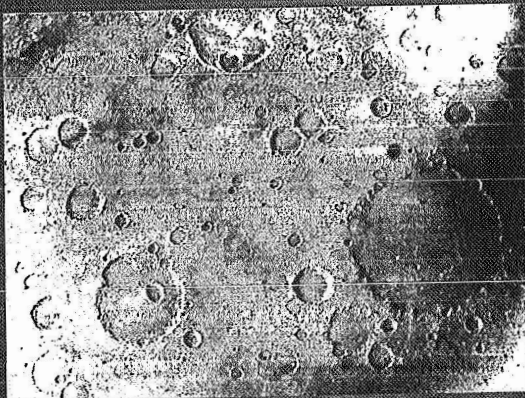


Human Centered Computing for Mars Exploration

Jay Trimble
NASA Ames Research Center
People Centered Innovation Conference
9/21/05

Mars Exploration

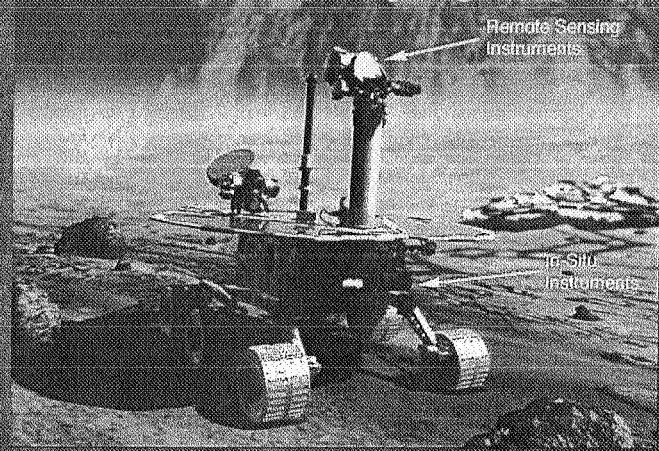


Mars Exploration Rover Mission

Science Objectives

--Determine the aqueous, climatic, and geologic history of a site on Mars where conditions may have been favorable to the preservation of evidence of pre-biotic or biotic processes

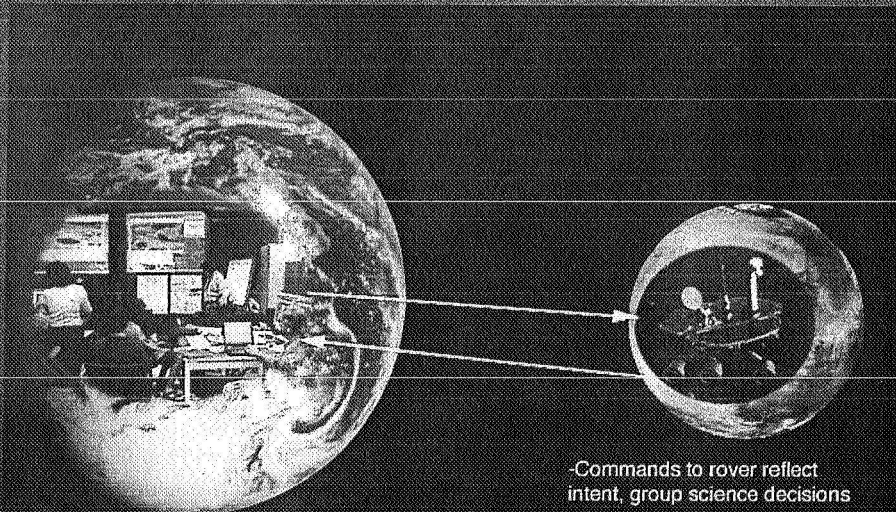
Rover acts as a remote field geologist on Mars



Jay Trimble

NASA Ames Research Center

MER Operations



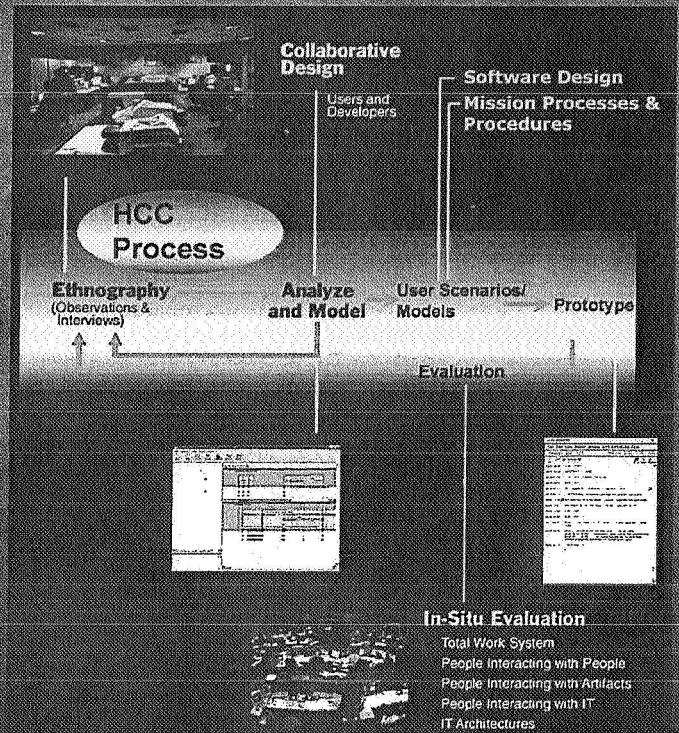
-Human Science Team with
Computer tools
-Intent, Qualitative Assessment, Judgement,
-Science Priorities, Resource
Management

Jay Trimble

NASA Ames Research Center

MER Human Centered Computing

- Proposed methods, not tools
 - Ethnography
 - Applied HCI
- Goal is mission impact on processes, procedures, tools
 - Safety
 - Productivity



Jay Trimble

NASA Ames Research Center

MER HCC Overview

- What is Human Centered Computing?
 - A development process that starts with users and their needs, rather than with technology. The goal is a system design that serves the user, where the technology fits the task and the complexity is that of the task not of the tool (D. Norman)
- Why Human Centered Computing?
 - MER Surface ops time is limited and expensive
 - \$Cost for MER surface operations
 - Daily productivity of a MER rover compared to human productivity, with adjustments for rover instrument capabilities that a human does not have
 - HCC will enhance safety and productivity of surface operations

HCC Methods for MER

• Ethnography

- How do people do their work vs. how people say they do their work
- Interviews
- Observations
- Used for broader observations of work practice, impact on workpractice

• HCI

- Interface design
- Quantitative measures

Observing

- Observations often reveal vast discrepancies between what people say they do and what people actually do (D. Norman)

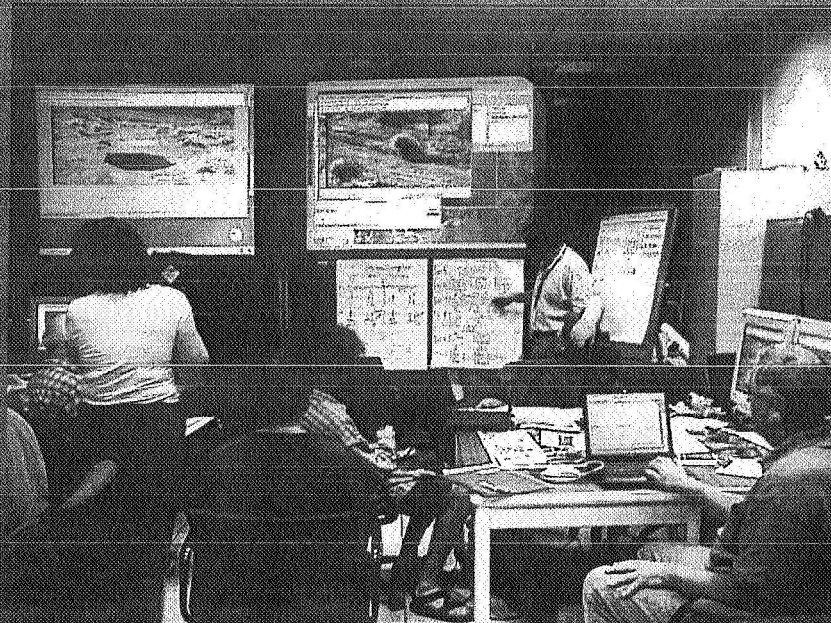
MER Ops

- Some Key MER ops Challenges
 - Twin rovers
 - Daily commanding
 - 3-shifts
 - Operations on Mars Time
 - Non-deterministic environment
 - Instrument observation dependencies
 - Decision process at JPL, no remote decisions

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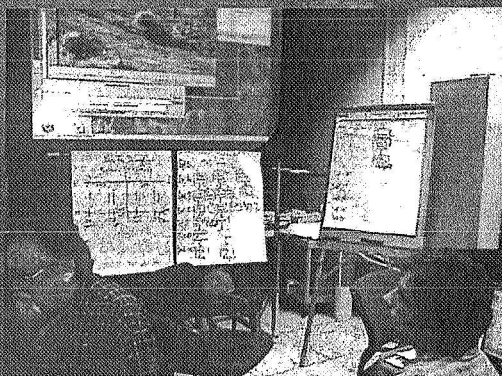
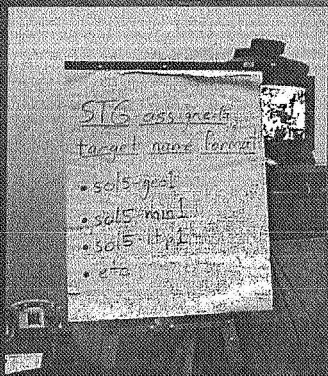
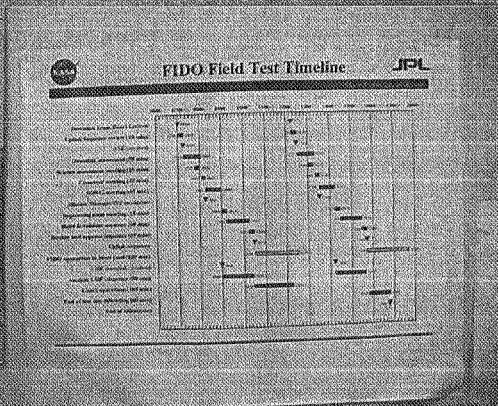
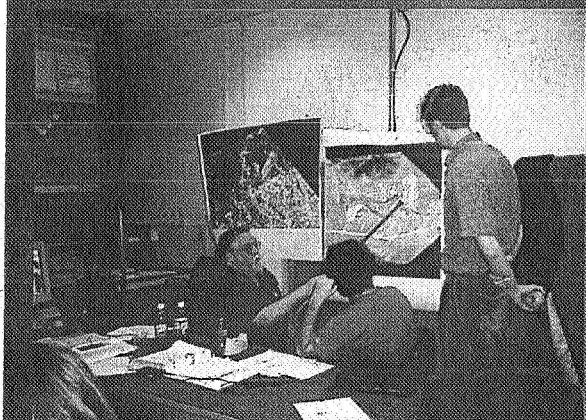
Observing Field Tests



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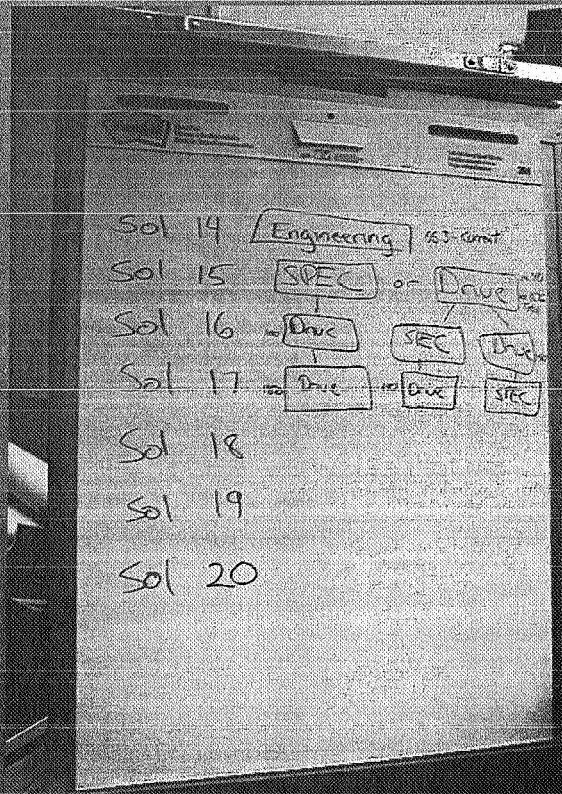
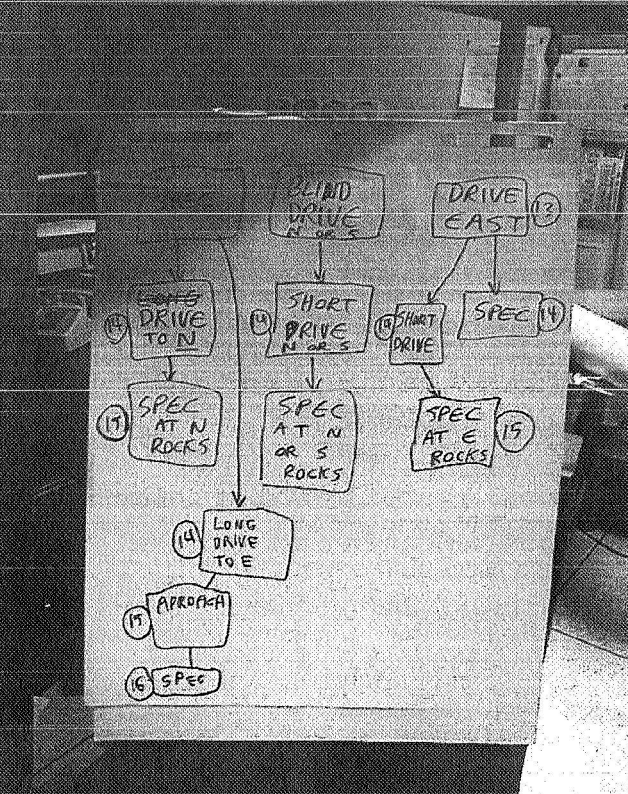
FIDO Field Test 2001



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Planning



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Unstructured Representations

Hypotheses to Test

- 1) If quartz mineralogy within hematite stain and minor feldspar, then:
 - in TES will see $qtz \pm \text{feldspar}$, not hematite
- (In orbital data some possible rover locations involve fans dominated by quartz, vs carbonate-dominated hills seen, potentially, in some directions)
- 2) Localized patches of exposed caliche in trough floor?
- * 3) Caliche exposed in trough/scarp ~~NO~~ ^{NO} ~~caliche~~ ^{caliche} ~~?~~ [?]
- ②+③ = what is the cementing agent? Where is the carbonate hiding?
- ④ 4) Are distant hills carbonate-rich?
 - (Perhaps pancam recon for carefully painted IPS) PROBABLY NOT
- 4 No. ~~3~~
- ④ Probably not

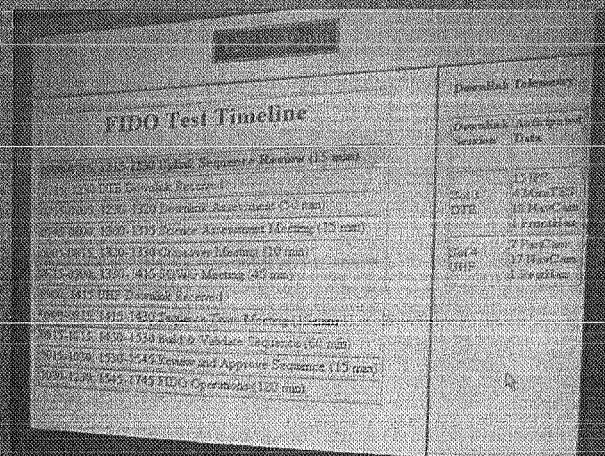
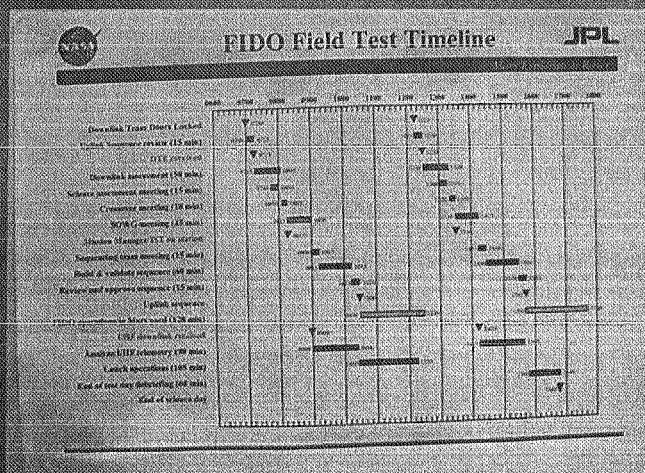
GUILD

MINUTES	IPS
<ul style="list-style-type: none"> • UNDERLYING ROCK (100µm) • Fe Rich SPOT 	<ul style="list-style-type: none"> • 10 µm DEPTH • ~2cm spot?
<p>SILICIC NO. 22</p> <p>PHYLOSILICATES</p> <p>W/ NO GLASS</p>	<p>7</p> <p>NO. PHYLO NOT AL. FE PHYL</p> <p>77</p>
<p>CARBONATE FEATURE</p> <p>↓</p> <p>CARBONATE ENDS ON SILICIC VOLCANIC ROCK IL DESERT VARNISH</p>	<p>NO CARBONATES</p> <p>↓</p> <p>DESERT VARNISH</p> <p>- APPROX. 20% Fe RICH SPOTS</p>

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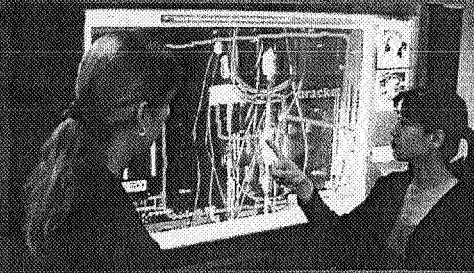
Time



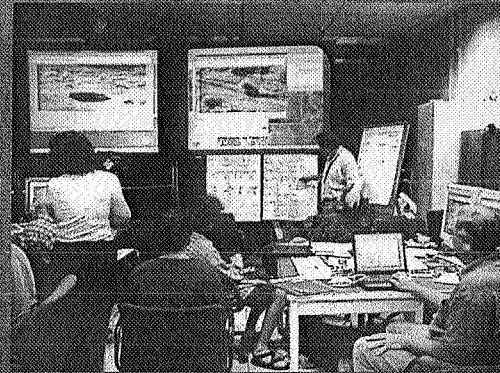
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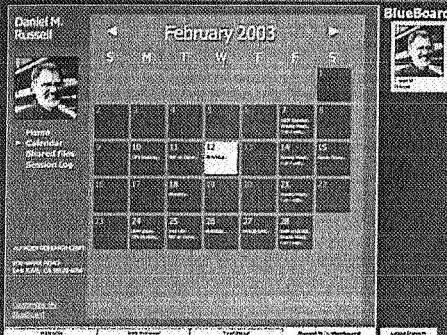
IBM Blueboard + FIDO = MERBoard



+



=



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MERBoard

- MERBoard proposed improvements in the following areas
 - Communication and sharing
 - Data display
 - Strategic planning
 - Visibility of presented material across the facility
 - Storage and retrieval of informal data representations and strategic plans
 - Information access

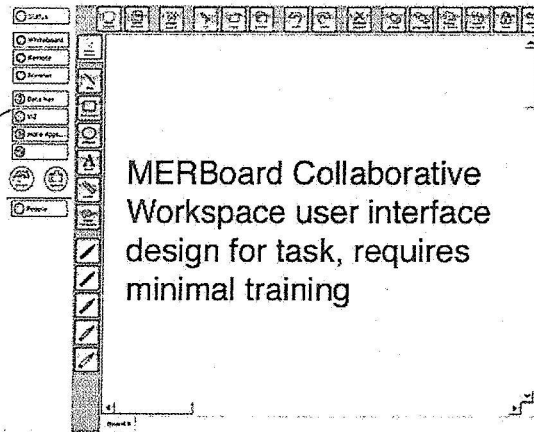
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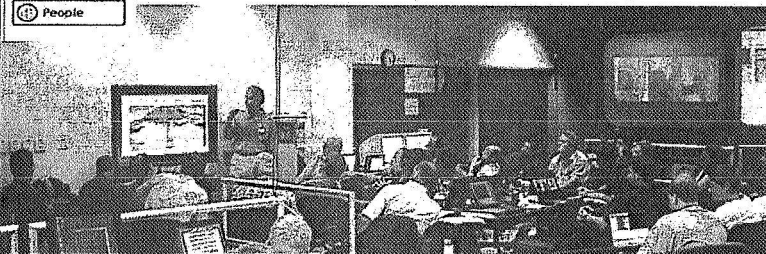
MERBoard



Collaborative content creation for mission planning



MERBoard Collaborative Workspace user interface design for task, requires minimal training



Ubiquitous access to information allows presentation from any board, viewing from multiple boards

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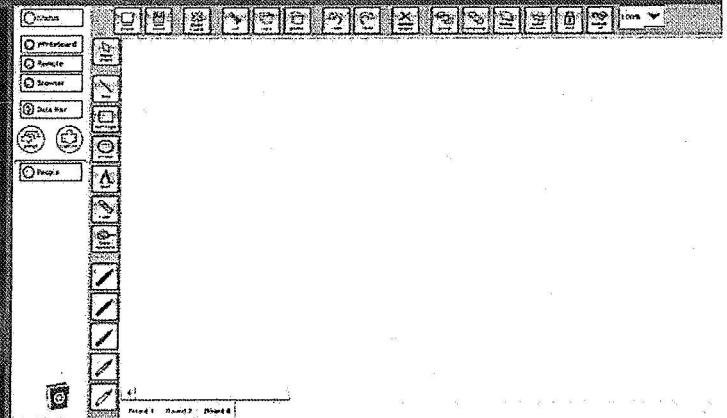
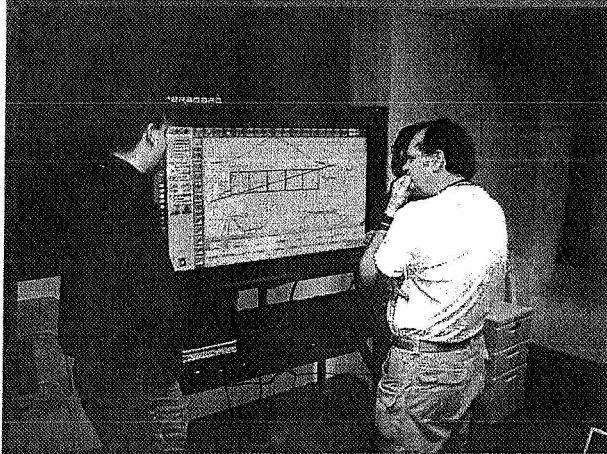
MERBoard Whiteboard

- ③ Support informal representations as seen at the field tests
- ③ Informal representations without fixed structures
- ③ Structured tools create thinking inside that structure
 - ③ Research has suggested that prolonging sketching, and therefore the ambiguous representations that are produced by sketching, will result in a broader exploration of the design space (Goel, 1995)
- ③ Provide an electronic tool to facilitate unstructured representations, add save, share, retrieve
- ③ Observe --> Unstructured Tools --> Structured Tools

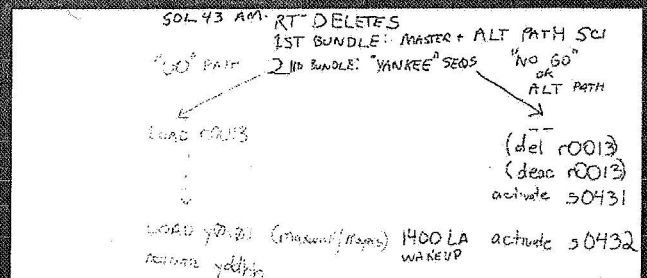
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MERBoard Whiteboard



Present, Save, retrieve,
ubiquitous access, owners,
versions

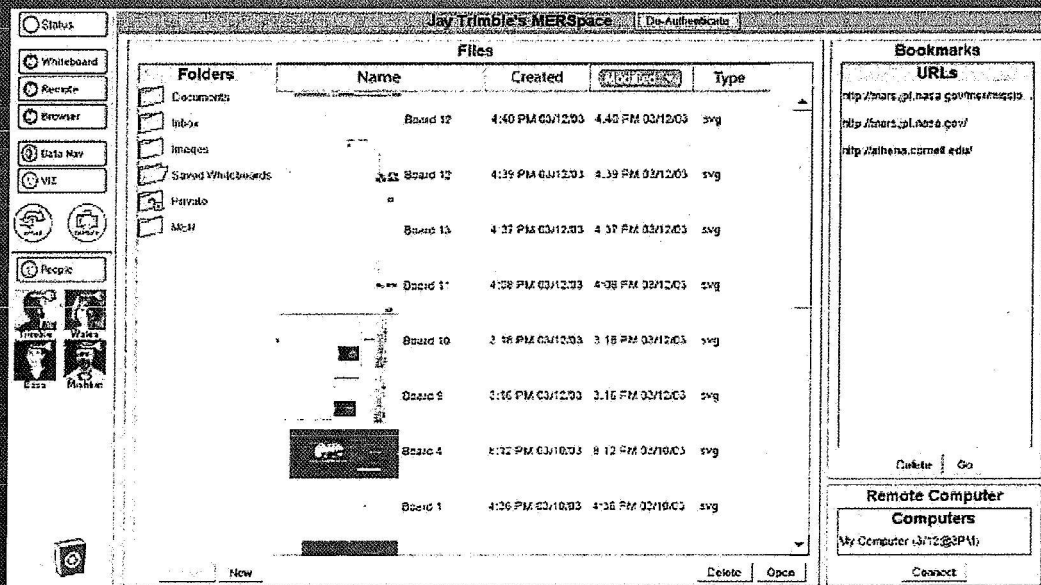


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MERSpace Design

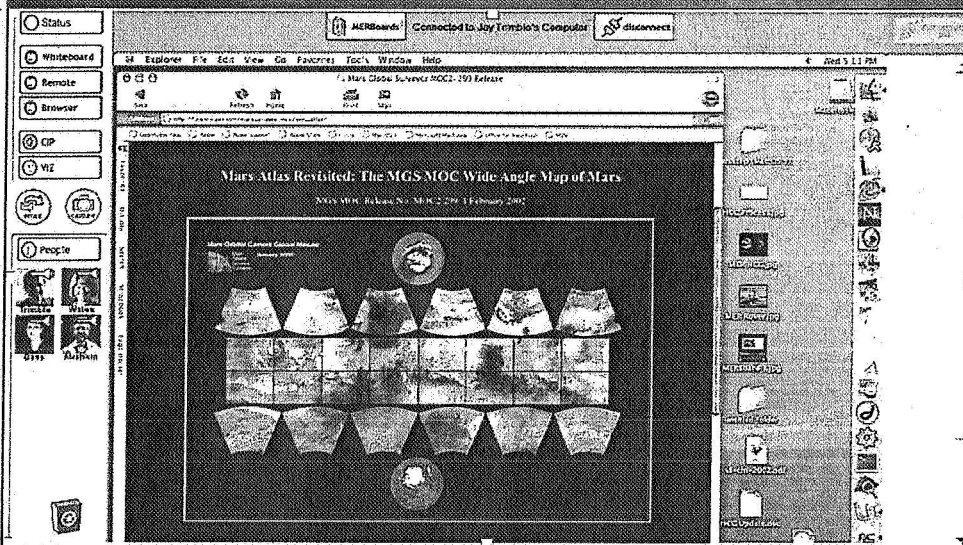
- Personal data in a collaborative space
- A consistent model for storing and retrieving data



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Remote Access



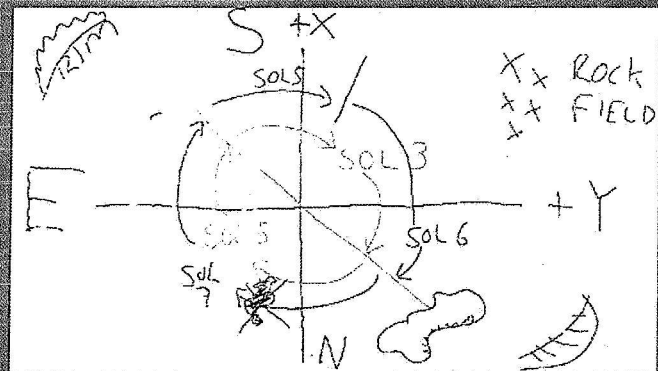
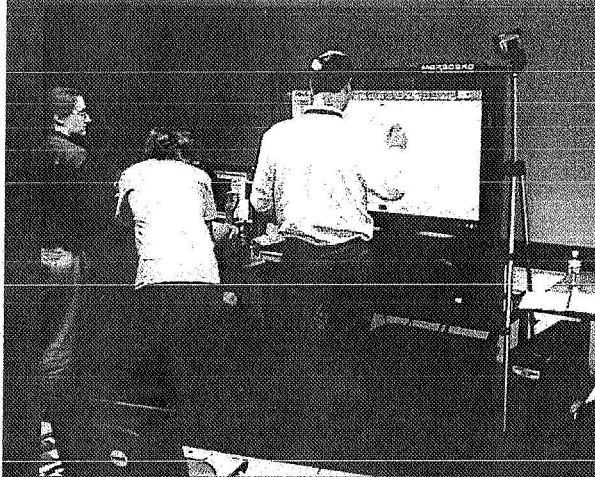
View, control,
capture, save

-Board to Board
-PC to Board

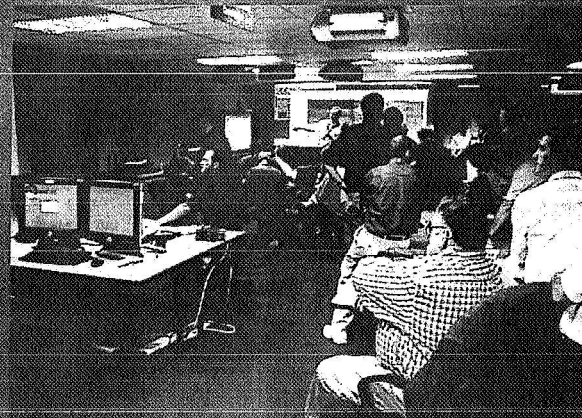
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Whiteboard Use in Surface Ops



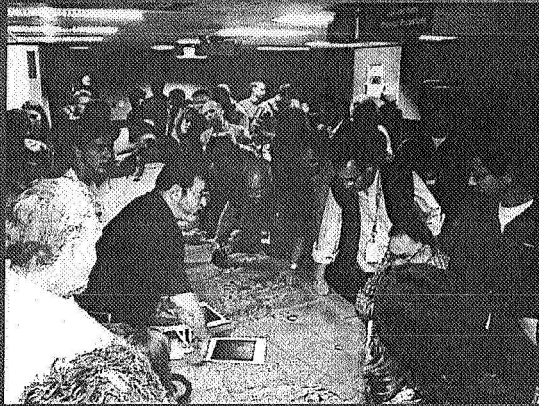
Write, broadcast,
present, save, recall



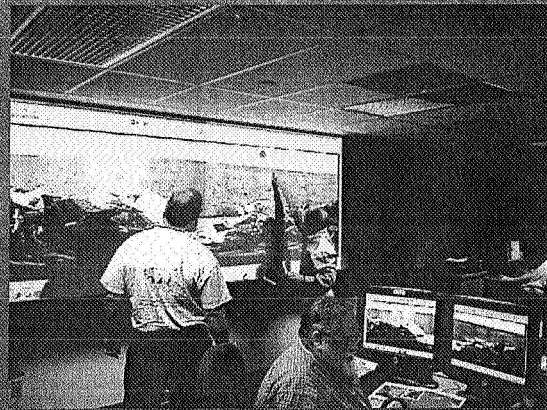
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Looking at Images

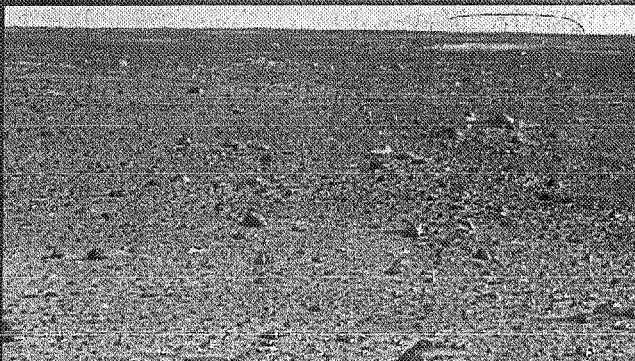
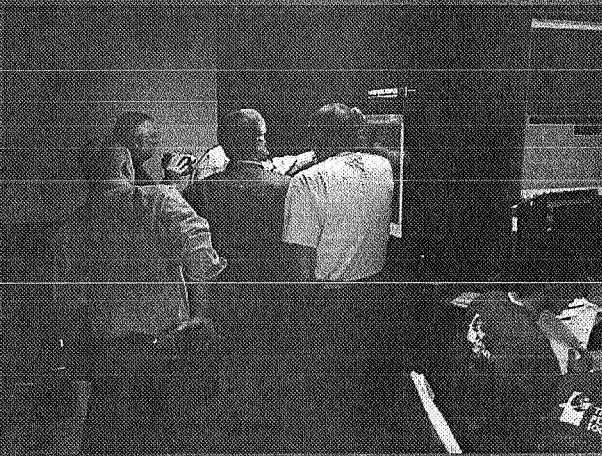


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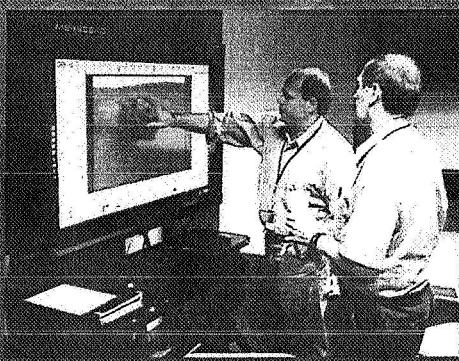


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Images



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Content

Traverse path to Bonneville Crater, created in personal environment, uploaded and displayed on MERBoard

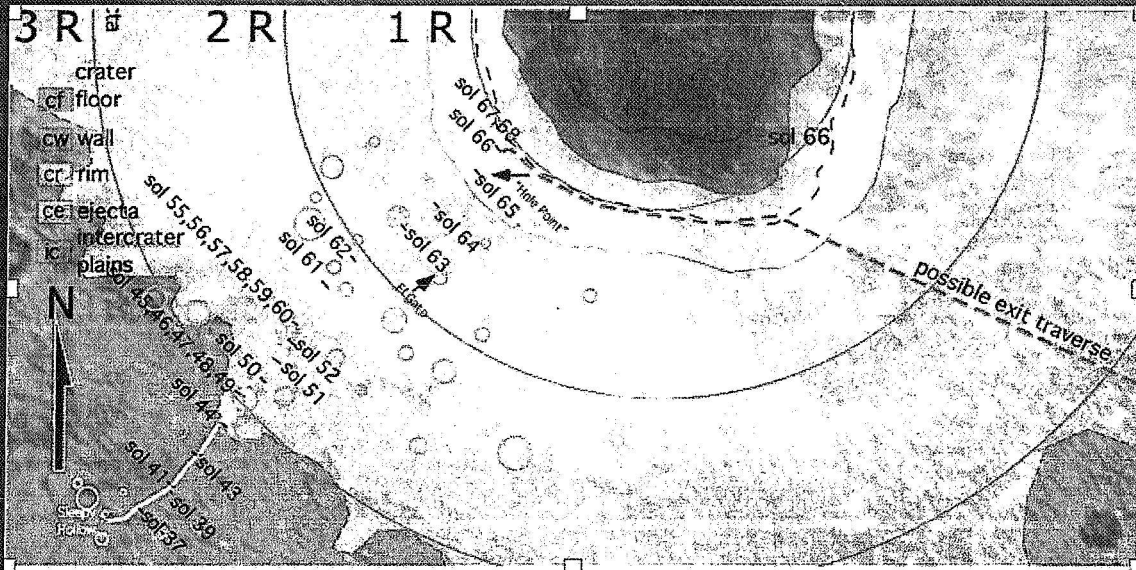
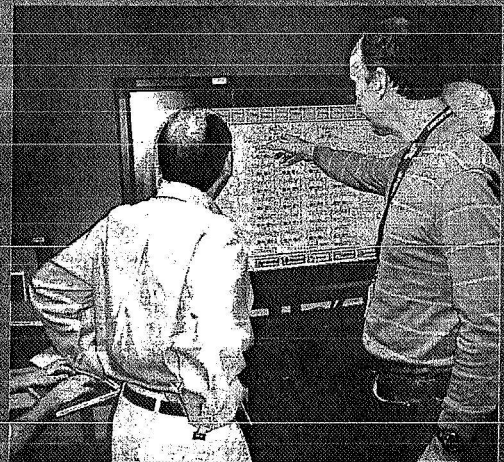


Image courtesy of Larry Crumpler

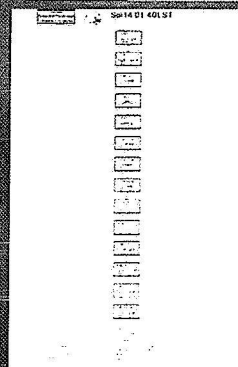
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Improved Work Practice



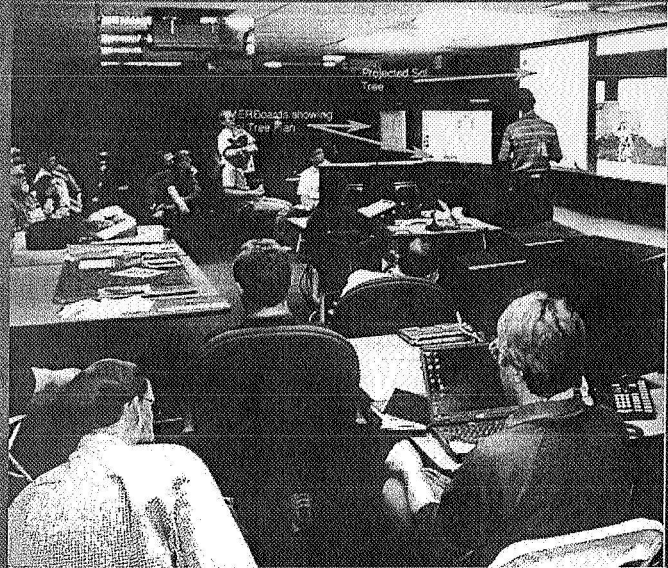
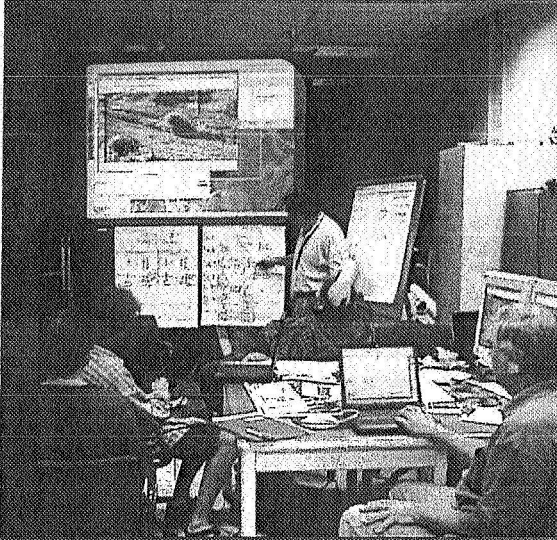
Sol 11	PAUSE	
Sol 12	PAUSE	
Sol 13	ADJ OPS	LOCATION 1
Sol 14	DRIVE	
Sol 15	DRIVE	
Sol 16	SCIENCE	DRIVE
Sol 17	SCIENCE	SCIENCE
Sol 18	DRIVE	SCIENCE
Sol 19-20	Mangler	



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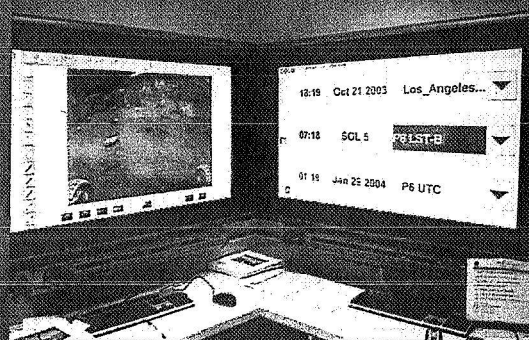
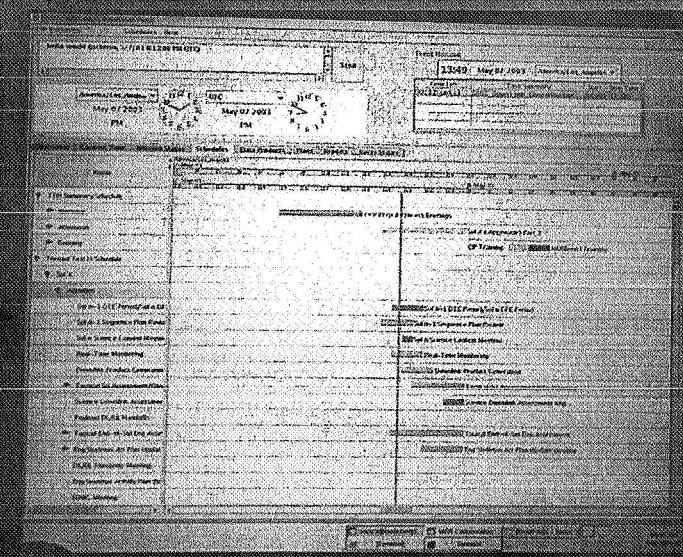
Presenting Sol Trees



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Time & Schedules



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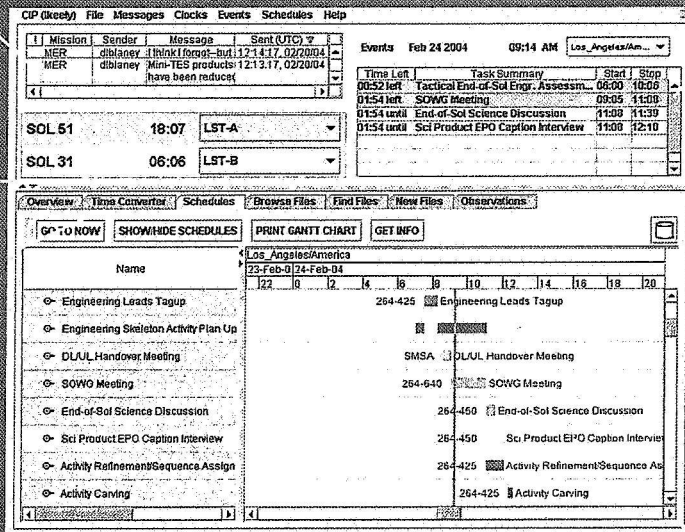
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Collaborative Information Portal for MER

Broadcast Messages

Clocks

Tabs for time conversion and data navigation tools



Event Countdown Timer

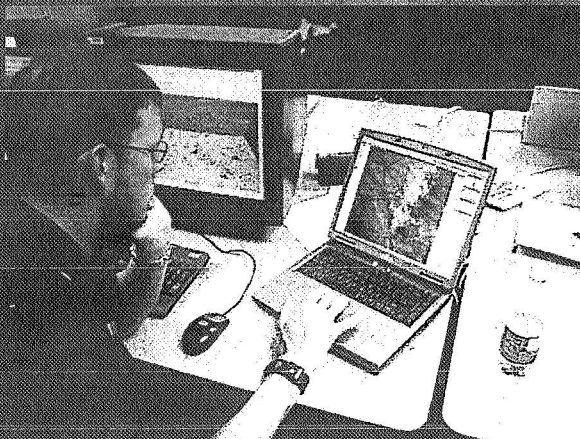
Schedule Viewer

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Personal tools

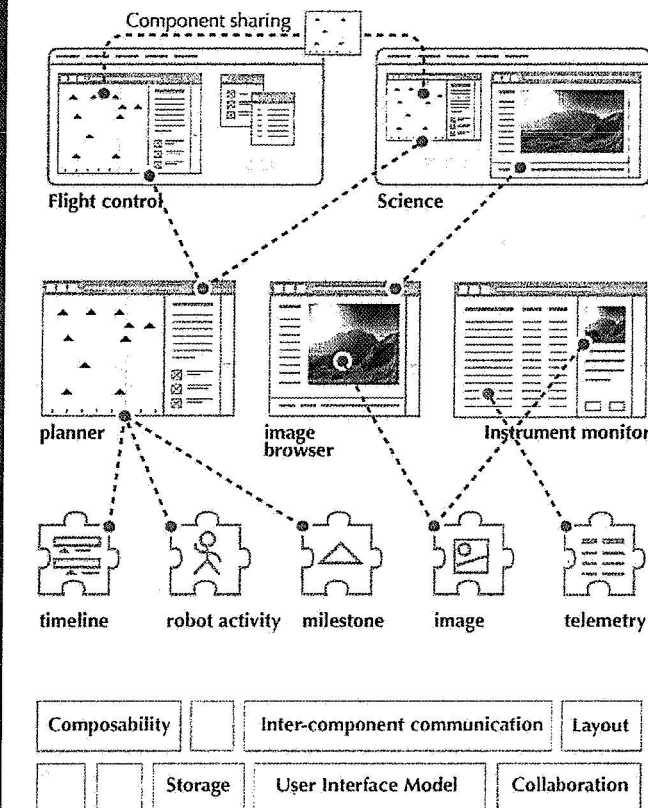
- Initial MER observations suggest that scientists default to their own tools
- Use mission tools when they fill a desired niche, or when required, future mission systems will benefit from interoperability



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Future Plans



Operational environments

are composed into

Composable applications

are composed into

Component repository

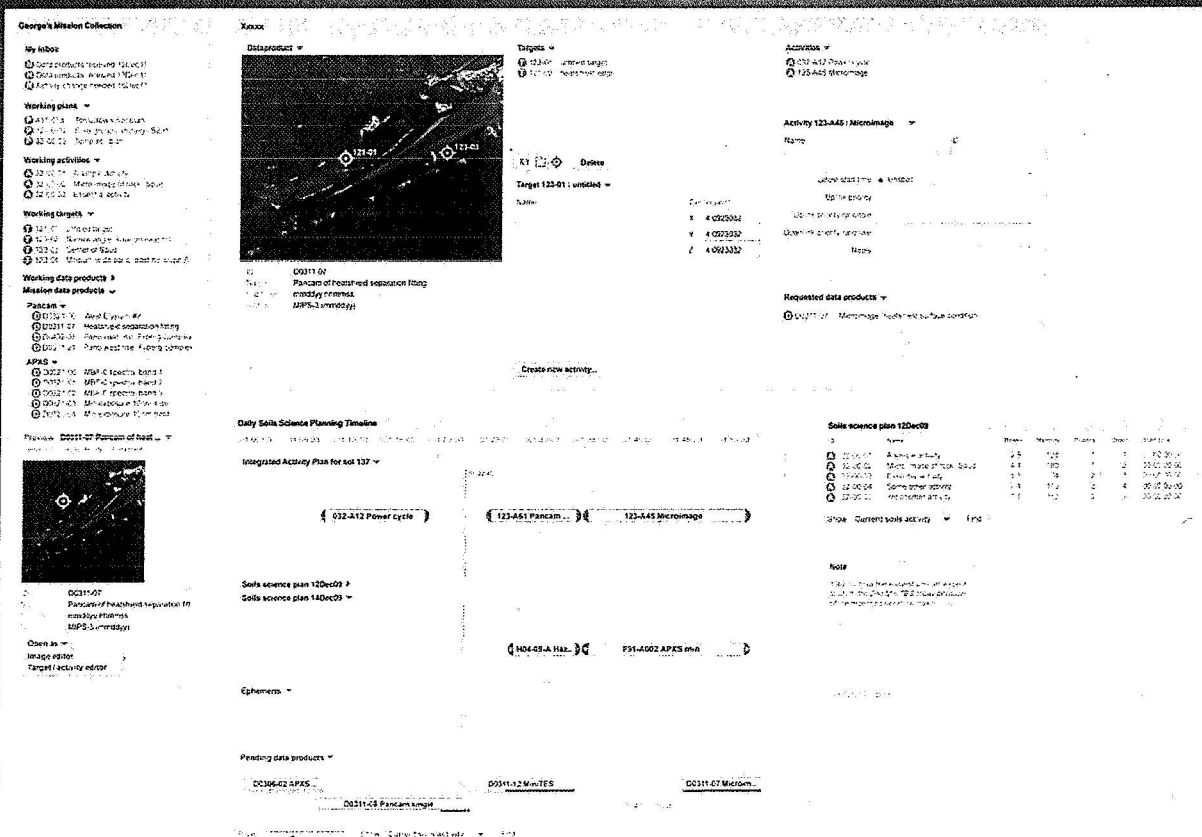
Frameworks

are used to build

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Arch Center

Future Plans



Jay

enter